Appendix C:
Risk Models from the Research

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List of Tables

List of Abbreviations and Acronyms

ADT	Average Daily Traffic
ADTT	Average Daily Truck Traffic
CIF	Constraint-induced Fracture
CF	Consequence Factor
CP	Corrosion Protection
CR	Condition Rating
CS	Condition State
Delam	Delamination
DE	Defect Element
EL	Element
HC	Horizontal clearance
LRF	Load Rating Factor
MBEI	Manual for Bridge Element Inspection
Mod.	Moderate
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NDT	Nondestructive Testing
NSTM	Nonredundant Steel Tension Member
OF	Occurrence Factor
POF	Probability of Failure
PSC	Prestressed Concrete
RAP	Reliability Assessment Panel
RBI	Risk Based Inspection
R/C	Reinforced Concrete
SS.	Superstructure
SNBI	Specification for the National Bridge Inventory
Stl	Steel
Sub	Substructure
tpd	Trucks Per Day
vpd	Vehicles Per Day
VC	Vertical Clearance

C.1 Introduction

This appendix includes risk models developed through the research. The risk models shown were developed from RAP input and include the list of attributes, attribute rank, and rating criteria for each damage mode identified by the RAP. The risk models were originally formed from the input from the individual RAPs and subsequently modified during course of the research. The risk models were modified to include attributes such as condition rating (CR) and condition state (CS), where appropriate and needed, to align the risk models more closely with guidance provided by the Federal Highway Administration (FHWA) for Method 2 risk analysis. Attributes associated with corrosion protection, such as reinforcing steel coating, concrete cover, overlay, and sealers were summarized into a single attribute of Corrosion Protection (CP) level, as described in the main body of the report.

The appendix begins with a table showing suggested screening criteria that could be adopted to meet some of the requirements of the National Bridge Inspection Standards and FHWA guidance on extended inspection intervals. Risk models developed by RAPs in Connecticut, Idaho, Illinois, Missouri, Washington, and Wisconsin are then presented, with separate risk models for each component and related damage mode.

C.1.1 General Screening Criteria

Table C.1 shows the screening criteria for scour based on the FHWA Method 1 requirements. The table also shows some suggested screening criteria for rotation for superstructures and substructures to address the FHWA guidance for Method 2 analysis, which requires rotation to be considered for both superstructures and substructures. The criteria shown are inclusive and describe the condition for a bridge component to be included in a Method 2 analysis. This is in contrast with the screening criteria developed from RAP input, which are generally exclusive with criteria that describe the conditions for a bridge to be excluded from a Method 2 analysis.

Table C.1. General screening criteria based on the FHWA Method 1 requirements.

Attribute	Coding Guide Item	MBEI	SNBI	Criteria
Scour Vulnerability	113		-	5, 8, or N
Scour Vulnerability	-	DE 6000	-	CS 3 < 10%, no CR 4
Scour Vulnerability	-	-	B.AP.03	A or B
Scour Condition Rating	-		B.C.11	≥ 6
Rotation (Superstructure)	59	-	-	CR > 4, bearing CS < 4
Rotation (Bearings)	-	-	B.C.07	CR > 4
Rotation (Bearings)	-	DE 2220	-	CS < 4
Rotation (Substructure)	60	-	-	CR > 4, CS < 4

C.2 Connecticut Risk Models

C.2.1 List of Damage Modes

Table C.2. Listing of damage modes for CT steel bridges.

Component	Damage Mode
Deck	Delamination / Spalling
Superstructure	Corrosion / Section Loss
Superstructure	Fatigue
Superstructure	Impact
Substructure	Delamination / Spalling
Substructure	Settlement / Movement
Substructure	Impact

C.2.2 Bridge Component Screening Criteria

Table C.3. Screening criteria for RBI in CT.

Code	Attribute	Criteria
S.1	Current CR	CR ≤ 4
S.16	Current Element CS	CS = 4
S.9	Significant Level of Active Corrosion or Section Loss	Extensive Length of section loss (Length of section loss affects repair strategy and analysis)
S.10	Design Features	Pin and hanger present
S.10	Design Features	Cover Plates with transverse welds in tension zones and/or failed cover plate or end weld (Existing policy to inspect biannually)
S.13	E or E’ Details	Bridge has E or E’ details, SNBI B.IR.02 = Y
S.8	Details Susceptible to CIF	Structure contains details susceptible to CIF (Cross Bracing w/ shelf plate welded to web, 60’’s - 70’’s era).
S.1 / S.16	Current CR / Current Element CS	Bearing in CS 3, 4 or CR ≤ 4 (B.C.07)
S.20	Settlement or Rotation	Active growing / monitoring tilting or tipping of substructure

C.2.3 Risk Models

Table C.4. Deck attributes and criteria for delamination and spalling in decks (CT).

Code	Attribute	Rank	Criteria	Rating
C.1	Current Condition Rating	High	CR 5	High
C.1	Current Condition Rating	High	CR 6	Mod.
C.1	Current Condition Rating	High	CR ≥ 7	Low
C.2	Element 510 Wearing Surface CS (Membrane Condition)	High	CS 3 ≥ 10% (pumping, known delamination or spalling, rutting, map cracking, or potholes)	High
C.2	Element 510 Wearing Surface CS (Membrane Condition)	High	1% ≤ CS 3 < 10%	Mod.
C.2	Element 510 Wearing Surface CS (Membrane Condition)	High	CS 3 < 1%	Low
-	Exposed Rebar Defect Element (DE) 1090	High	Exposed rebar with section loss, DE 1090 (exposed rebar) CS 3	High
-	Exposed Rebar Defect Element (DE) 1090	High	Exposed rebar or known delamination DE 1090 (exposed rebar) CS 2 or DE 1080 (Delam / spall) CS 2	Mod.
-	Exposed Rebar Defect Element (DE) 1090	High	No exposed rebar	Low
C.4	Joint Condition	High	Joint in CR 4 or 5 or joint CS 3 ≥ 5%, CS 2 ≥ 20%,	High
C.4	Joint Condition	High	Joint in CR 6, Joint CS 0 < CS 3 < 5%, 5% < CS 2 < 20%	Mod.
C.4	Joint Condition	High	Jointless/joint in CR ≥ 7, Joint In-place with joint CS 2 ≤ 5%, no CS 3	Low
C.13	Soffit Condition / Leakage / Efflorescence / Staining (DE 1120)	High	DE 1120 (Efflorescence) CS = 3 or CS = 4	Very High
C.13	Soffit Condition / Leakage / Efflorescence / Staining (DE 1120)	High	DE 1120 (Efflorescence) CS = 2	Mod.
C.13	Soffit Condition / Leakage / Efflorescence / Staining (DE 1120)	High	DE 1120 (Efflorescence) No leakage, CS = 1	Low
L.1	ADT	Mod.	ADT > 10,000 vpd	High
L.1	ADT	Mod.	1,000 vpd < ADT < 10,000 vpd	Mod.
L.1	ADT	Mod.	ADT < 1,000 vpd	Low
L.5	Rate of Deicing Chemical Application	Mod.	Interstate / urban	High
L.5	Rate of Deicing Chemical Application	Mod.	Other routes	Mod.
L.5	Rate of Deicing Chemical Application	Mod.	Rural non interstate	Low
D.26	Corrosion Protection Level	High	CP 1	V. High
D.26	Corrosion Protection Level	High	CP 2	High
D.26	Corrosion Protection Level	High	CP 3	Mod.
D.26	Corrosion Protection Level	High	CP 4	Low

Table C.5. Steel superstructure corrosion damage (CT).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element CS	High	Element CS 3 ≥ 5%	High
C.2	Current Element CS	High	Element CS 3 < 5%, CS 2 > 10%	Mod.
C.2	Current Element CS	High	Other	Low
D.15 / C.17	Constructed of Weathering Steel / Protective Coating Condition	High	Element 515 CS 3 or CS 4	High
D.15 / C.17	Constructed of Weathering Steel / Protective Coating Condition	High	Weathering steel with unpainted end or element 515 CS 2	Mod.
D.15 / C.17	Constructed of Weathering Steel / Protective Coating Condition	High	Weathering steel with coated ends, Metallized, Galvanized, coating element 515 CS 1	Low
C.4	Joint Condition	High	Joint in CR 4 or 5 or joint CS 3 ≥ 5%, CS 2 ≥ 20%,	High
C.4	Joint Condition	High	Joint in CR 6, Joint CS 0 < CS 3 < 5%, 5% < CS 2 < 20%	Mod.
C.4	Joint Condition	High	Jointless/joint in CR ≥ 7, Joint In-place with joint CS 2 ≤ 5%, no CS 3	Low
L.5	Rate of Deicing Chemical Application	Mod.	Interstate / urban	High
L.5	Rate of Deicing Chemical Application	Mod.	Other NHS	Mod.
L.5	Rate of Deicing Chemical Application	Mod.	Rural, non-NHS	Low
L.6	Subjected to Overspray	Mod.	Weathering steel inside splash zone (≤ 20' vertical clearance), coated steel over interstate ≤ 17 ft vertical clearance	High
L.6	Subjected to Overspray	Mod.	Coated steel over interstate with VC> 17 ft, < 20 ft	Mod.
L.6	Subjected to Overspray	Mod.	Coated steel and/or ≥ 20' vertical clearance	Low
C.7	Effectiveness of Deck Drainage	High	Unaddressed leakage / joints runoff unto substructure, CR 4 (Inspection Manual)	High
C.7	Effectiveness of Deck Drainage	High	Drainage issues that have been mitigated, CR 5-6 (Inspection Manual)	Mod.
C.7	Effectiveness of Deck Drainage	High	No drainage issues, CR ≥ 7 (Insp. Manual)	Low
C.5	Maintenance Cycle	Low	No maintenance	High
C.5	Maintenance Cycle	Low	Full maintenance (Contract maintenance, patching, Sealing) Joints are done on asphalt rehabs	Low

Table C.6. Fatigue cracking damage mode attributes and criteria (CT).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element CS	High	DE 1010 CS 2 (arrested cracking)	High
C.2	Current Element CS	High	No DE 1010 CS 2 (no cracking reported)	Low
L.1	ADT / ADTT	High	ADT > 10,000 vpd	High
L.1	ADT / ADTT	High	1,000 vpd < ADT < 10,000 vpd	Mod.
L.1	ADT / ADTT	High	ADT < 1,000 vpd	Low
D.17	Worst Fatigue Detail Category	High	D	High
D.17	Worst Fatigue Detail Category	High	C	Mod-low
D.17	Worst Fatigue Detail Category	High	A, B	Low
D.6	Year of Construction	High	Designed before 1975	High
D.6	Year of Construction	High	Designed between 1975 and 1984	Mod-hi
D.6	Year of Construction	High	Designed between 1985 and 1993	Mod.
D.6	Year of Construction	High	Designed after 1994	Low
D.16	Element Connection Type (Secondary Member Connections)	Mod.	Elements connected with welds	High
D.16	Element Connection Type (Secondary Member Connections)	Mod.	Elements connected with rivets	Mod.
D.16	Element Connection Type (Secondary Member Connections)	Mod.	Elements connected with HS bolts	Low

Table C.7. Impact damage attributes and criteria (CT).

Code	Attribute	Rank	Criteria	Rating
D.3	Minimum Vertical Clearance	High	VC ≤ 14.5 ft	High
D.3	Minimum Vertical Clearance	High	14.5 ft < VC ≤ 17 ft	Mod.
D.3	Minimum Vertical Clearance	High	> 17 ft	Low
D.25	Feature Under	Mod.	Over traffic/Roadway, high ADT (ADT > 10,000 vpd)	High
D.25	Feature Under	Mod.	Roadway, moderate ADT (1,000 vpd < ADT < 10,000 vpd)	Mod.
D.25	Feature Under	Mod.	Roadway, moderate ADT (ADT < 1,000 vpd)	Low
-	Condition Rating (Collision)	High	7	High
-	Condition Rating (Collision)	High	8	Mod.
-	Condition Rating (Collision)	High	9	Low

Table C.8. Substructure settlement damage mode, attribute, and attribute's criteria (CT).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2 / C.9	Current Element CS (General Cracking)	High	Large cracks, CS 3 DE 1130 > 1%	High
C.2 / C.9	Current Element CS (General Cracking)	High	Mitigated cracks or settlement CS 2 >10 % DE 1130	Mod.
C.2 / C.9	Current Element CS (General Cracking)	High	Without cracks or settlement CS 1, CS 2 ≤ 10% DE 1130	Low
C.24	Bearing Condition Rating / State	High	Handled as a screening criterion	Screen
C.3	Evidence of Rotation or Settlement	High	Large, active, or unstable settlement DE 4000 (Settlement) CS 3 ≥ 10%	High
C.3	Evidence of Rotation or Settlement	High	Inactive or stable settlement DE 4000 CS 3 < 10% or CS 2	Mod.
C.3	Evidence of Rotation or Settlement	High	Without displacements DE 4000 CS 1	Low

Table C.9. Table showing attributes for vehicle impact for substructures (CT).

Code	Attribute	Rank	Criteria	Rating
D.29	Feature Under the Bridge	Mod.	Over traffic / Roadway, high ADT (ADT > 10,000 vpd)	High
D.29	Feature Under the Bridge	Mod.	Roadway, moderate ADT (1,000 < ADT < 10,000 vpd)	Mod.
D.29	Feature Under the Bridge	Mod.	Roadway, low ADT (ADT < 1,000 vpd) / Anything else	Low
-	Horizontal Clearance	High	Unprotected piers, ≤ 50 ft HC	High
-	Horizontal Clearance	High	Unprotected piers, 50 ft < HC ≤ 100 ft	Mod
-	Horizontal Clearance	High	HC > 100 ft	Low
-	Collision Damage Rating	High	CR ≤ 6	High
-	Collision Damage Rating	High	6 ≤ CR ≤ 8	Mod.
-	Collision Damage Rating	High	CR 9, unrated	Low

Table C.10. Categorical model for substructure impact damage.

OF Category	Criteria
High	High ADT ≥ 10,000 vpd, ≤ 20 ft HC (unprotected)
Moderate	High ADT ≥ 10,000, 20 ft < HC < 50 ft clearance (unprotected)
Low	High ADT ≥ 10,000 vpd, 50 ft < HC ≤ 100 ft (unprotected) Moderate ADT (1,000 vpd < ADT < 10,000 vpd), HC < 50 ft (unprotected)
Remote	Protected, Roadway, low ADT (ADT < 1,000 vpd) / Anything else, HC > 50 ft horizontal clearance (unprotected)

C.3 Idaho Risk Models

C.3.1 Damage Modes

Table C.11. Listing of damage modes for Idaho PSC bridges.

Component	Damage Mode
Deck	Delamination / Spalling
Superstructure	Delamination / Spalling
Superstructure	Cracking
Superstructure	Impact Damage
Substructure	Delamination / Spalling and Cracking due to Corrosion

C.3.2 Screening Criteria

Table C.12. Deck, superstructure & substructure screening attributes and criteria (ID).

Code	Attribute	Criteria
S.1	Current CR	CR ≤ 4
S.16	Current Element CS	Element in CS 4 Deck, Superstructure, Substructure & Bearing Elements
C.23	Wear / Abrasion or Rutting	Presence of wear / abrasion rutting, Defect 1190 CS 3 > 5%
D.6	Year of Construction	Currently > 60 years old
S.17	Construction Quality	Known defect in material and / or construction quality
S.18	Exposed Strands	Exposed Strands (DE 1100) caused by impact
S.19	LRF	Shear LRF < 1.0
S.20	Settlement or Rotation (Erosion (Scour))	Significant amount of erosion / scour / settlement DE 4000, DE 6000 CS 3 > 20%

C.3.3 Risk Models

Table C.13. Deck damage mode, attribute, and attribute's criteria (ID).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element CS	High	CS 3 ≥ 5% or CS 2 ≥ 20%	High
C.2	Current Element CS	High	1% ≤ CS 3 < 5% or 10% ≤ CS 2 < 20%	Mod.
C.2	Current Element CS	High	CS 3 < 1% or CS 2 < 10%	Low
C.4	Joint Condition	Mod.	DE 2360 ≥ 20% CS 3 / CS 4	High
C.4	Joint Condition	Mod.	DE 2360 1% ≤ CS 3 / CS 4 < 20%	Mod.
C.4	Joint Condition	Mod.	DE 2360 CS 1 or CS 2, no CS 3	Low
C.13	Efflorescence / Staining	Low	DE 1120: CS 3 ≥ 20% or CS 2 ≥ 20%	High
C.13	Efflorescence / Staining	Low	DE 1120: 1% ≤ CS 3 < 20% or 5% ≤ CS 2 < 20%	Mod.
C.13	Efflorescence / Staining	Low	DE 1120: CS 3 < 1% or CS 2 < 5%	Low
L.1	ADT or ADTT	Mod.	ADTT ≥ 5000 tpd or ADT ≥ 16,000 vpd	High
L.1	ADT or ADTT	Mod.	1000 tpd ≤ ADTT < 5000 tpd or 7500 vpd ≤ ADT < 16000 vpd	Mod.
L.1	ADT or ADTT	Mod.	ADTT < 1000 tpd or ADT < 7500 vpd	Low
L.5	Rate of Deicing Chemical Application	Low	Interstate / NHS or ADT ≥ 16,000 vpd	High
L.5	Rate of Deicing Chemical Application	Low	ADT between 7500 & 16,000 vpd	Mod.
L.5	Rate of Deicing Chemical Application	Low	Local, Low ADT ≤ 7,500 vpd	Low
D.26	Corrosion Protection Level	Mod.	CP 1	Very High
D.26	Corrosion Protection Level	Mod.	CP 2	High
D.26	Corrosion Protection Level	Mod.	CP 3	Mod.
D.26	Corrosion Protection Level	Mod.	CP 4	Low
D.6	Year of Construction	Low	> 40 years	High
D.6	Year of Construction	Low	20 to 40 years	Mod.
D.6	Year of Construction	Low	< 20 years	Low
C.5	Maintenance Cycles	Mod.	No Maintenance	High
C.5	Maintenance Cycles	Mod.	Full maintenance (Contract maintenance, patching, sealing)	Low

Table C.14. PSC superstructure attributes and criteria for delamination and spalling (ID).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element CS	High	CS 3 ≥ 1% or CS 2 ≥ 20%	High
C.2	Current Element CS	High	CS 3 < 1% or 5% ≤ CS 2 < 20%	Mod.
C.2	Current Element CS	High	No CS 3, CS 2 < 5%	Low
C.4	Joint Condition	Mod.	CR 4 & 5, ≥ 20% CS 3 / CS 4	High
C.4	Joint Condition	Mod.	CR 6, 1% ≤ CS 3 / CS 4 < 20%	Mod.
C.4	Joint Condition	Mod.	CR ≥ 7, CS 1 or 2, CS 3 < 1%	Low
L.1	ADT / ADTT	Mod.	ADTT ≥ 5000 tpd or ADT ≥ 16,000 vpd	High
L.1	ADT / ADTT	Mod.	1000 tpd ≤ ADTT < 5000 tpd or 7500 vpd ≤ ADT < 16000 vpd	Mod.
L.1	ADT / ADTT	Mod.	ADTT < 1000 tpd or ADT < 7500 vpd	Low
L.5	Rate of Deicing Chemical Application	Mod.	Interstate / NHS or ADT ≥ 16,000 vpd	High
L.5	Rate of Deicing Chemical Application	Mod.	7500 vpd < ADT < 16,000 vpd	Mod.
L.5	Rate of Deicing Chemical Application	Mod.	Local, Low ADT ≤ 7,500 vpd	Low
C.7	Effectiveness of Deck Drainage	Low	CR 5 Deck with DE 1120 CS 3 or CS 2 > 20%	High
C.7	Effectiveness of Deck Drainage	Low	CR 5 deck	Mod.
C.7	Effectiveness of Deck Drainage	Low	CR ≥ 6 deck	Low
D.1	Joint Type	Mod.	Compression, J series	High
D.1	Joint Type	Mod.	Strip Seal	Mod.
D.1	Joint Type	Mod.	Jointless	Low
D.24	Structure Type	Low	Deck bulb tees with longitudinal joints	High
D.24	Structure Type	Low	Any not defined as *high* or *low*	Mod.
D.24	Structure Type	Low	AASHTO – Stringer, regular bulb tees	Low

Table C.15. Idaho PSC cracking damage mode attributes and criteria.

Code	Attribute	Rank	Criteria	Rating
D.2	Load Posting (Overload)	High	Structure is load posted	High
D.2	Load Posting (Overload)	High	Structure is not load posted	Low
D.18	Skew	High	Skew ≥ 30°	High
D.18	Skew	High	20°< Skew < 30°	Mod.
D.18	Skew	High	Skew ≤ 20°	Low
D.6	Year of Construction	High	Age > 50 years	High
D.6	Year of Construction	High	Currently < 50 years	Low
C.2	Current Element CS (General Cracking, Defect Element 1110 – Cracking (PSC))	High	CS 3 ≥ 1% or CS 2 ≥ 20%	High
C.2	Current Element CS (General Cracking, Defect Element 1110 – Cracking (PSC))	High	CS 3 < 1% or 5% ≤ CS 2 < 20%	Mod.
C.2	Current Element CS (General Cracking, Defect Element 1110 – Cracking (PSC))	High	No CS 3 or CS 2 < 5%	Low

Table C.16. Idaho PSC impact damage attributes and criteria.

Code	Attribute	Rank	Criteria	Rating
C.26	Debris Impact	High	Item 71 CR ≤ 4 (overtopping) (SNBI B.AP.02 ≥ 5)	High
C.26	Debris Impact	High	SNBI B.AP.02 = 4	Mod.
C.26	Debris Impact	High	Others	Low
D.3	Minimum Vertical Clearance	High	14 ft- 16 ft 6 in. with high ADT	High
D.3	Minimum Vertical Clearance	High	14 ft – 16 ft 6 in.	Mod.
D.3	Minimum Vertical Clearance	High	> 16 ft 6 in.	Low
L.1	ADT (feature under)	Mod.	High ADT (> 5000 vpd)	High
L.1	ADT (feature under)	Mod.	Moderate ADT (1000 vpd- 5000 vpd)	Mod.
L.1	ADT (feature under)	Mod.	Low ADT (< 1000 vpd)	Low

Table C.17. Concrete substructure damage mode, attribute, and criteria (ID).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element CS	High	CS 3 ≥ 5% or CS 2 ≥ 20%	High
C.2	Current Element CS	High	1% ≤ CS 3 < 5% or 5% ≤ CS 2 < 20%	Mod.
C.2	Current Element CS	High	CS 3 < 1% or CS 2 < 5%	Low
C.4	Joint Condition	High	CR 4 & 5, ≥ 20% CS3 / CS 4, DE 2310 CS 3	High
C.4	Joint Condition	High	Joint in CR 6, 1% ≤ CS 3 / CS 4 < 20%	Mod.
C.4	Joint Condition	High	CR ≥ 7, In-place, CS 1 or CS 2, CS 3 < 1%	Low
C.13	Efflorescence / Staining	High	DE 1120: CS 3 ≥ 20% or CS 2 ≥ 20%	High
C.13	Efflorescence / Staining	High	DE 1120: 1% ≤ CS 3 < 20% or 5% ≤ CS 2 < 20%	Mod.
C.13	Efflorescence / Staining	High	DE 1120: CS 3 < 1% or CS 2 < 5%	Low
L.5	Rate of Deicing Chemical Application	High	Interstate / NHS or ADT ≥ 16,000 vpd	High
L.5	Rate of Deicing Chemical Application	High	7500 vpd < ADT < 16,000 vpd	Mod.
L.5	Rate of Deicing Chemical Application	High	Local, Low ADT ≤ 7,500 vpd	Low
D.26	Corrosion Protection Level*	High	CP 1	Very high
D.26	Corrosion Protection Level*	High	CP 2	High
D.26	Corrosion Protection Level*	High	CP 3	Mod.
D.26	Corrosion Protection Level*	High	CP 4	Low

C.4 Illinois Risk Models

C.4.1 Damage Modes

Table C.18. Listing of damage modes for Illinois steel bridges.

Component	Damage Mode
Deck	Delamination / Spalling
Superstructure	Corrosion / Section Loss
Superstructure	Fatigue
Superstructure	Vehicle Impact
Substructure	Delamination / Spalling
Substructure	Rotation / Settlement
Substructure	Vehicle / Vessel Impact

C.4.2 Screening Criteria

Table C.19. Deck, superstructure and substructure screening attributes and criteria (IL).

Code	Attribute	Criteria
S.1	Current Condition Rating	CR ≤ 4
S.16	Current Element CS	CS 4
S.4	Flexural Cracking	Flexural Cracking present based on inspection results.
S.5	Shear Cracking	Shear Cracking present based on inspection results.
S.10 / D.5	Design Features / Use of Open Decking	Use of Open Decking Steel or Timber (Open Grid, etc.) deck
D.1 / S.10	Joint Type / Design Features	Fingerplate without troths or with failed troths, Sliding plate joints, or other open joint
S.7	Active Fatigue Cracks Due to Primary Stress Ranges	Existing Cracking in steel member with DE 1010 CS 3
S.8	Details Susceptible to CIF	Superstructure has CIF details
S.10	Design Features	Timber piles or timber pile bents (local system)
S.17	Construction Quality	Known construction quality issues including defects or poor material quality
S.20	Settlement or Rotation	Evidence of rotation or settlement DE 4000- CS 3 >20% - or noted moderate to severe rotation or settlement or wide cracks resulting from rotation or settlement, DE 1130 CS 3 > 20%
D.22	Subsurface Soil Condition	Evidence of mine subsidence

C.4.3 Risk Models

Table C.20. Deck damage mode, attribute, and attribute's criteria (IL).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR 7	Low
C.2	Element CS	High	CS 3 ≥ 5% or CS 2 ≥ 20%	High
C.2	Element CS	High	1% ≤ CS 3 < 5% or 5% ≤ CS 2 < 20%	Mod.
C.2	Element CS	High	CS 3 < 1% or CS 2 < 5%	Low
L.1	Average Daily Truck Traffic	Mod.	ADTT ≥ 5,000 vpd	High
L.1	Average Daily Truck Traffic	Mod.	500 < ADTT < 4,999 vpd	Mod.
L.1	Average Daily Truck Traffic	Mod.	ADTT ≤ 500 vpd	Low
L.5	Rate of Deicing Chemical Application	High	North of I-80, High ADT (ADT > 10, 000 vpd)	High
L.5	Rate of Deicing Chemical Application	High	Between I-70 and I-80, High ADT (ADT > 10,000 vpd)	Mod.
L.5	Rate of Deicing Chemical Application	High	South of I-70, Low ADT < 10,000 vpd	Low
L.4	Likelihood of Overload	Mod.	High likelihood of overload, Permit routes	High
L.4	Likelihood of Overload	Mod.	Moderate likelihood of overload	Mod.
L.4	Likelihood of Overload	Mod.	Low likelihood of overload	Low
D.26	Corrosion Protection Level	High	CP 1	Very High
D.26	Corrosion Protection Level	High	CP 2	High
D.26	Corrosion Protection Level	High	CP 3	Mod.
D.26	Corrosion Protection Level	High	CP 4	Low
D.6	Year of Construction	High	> 25 Years old	High
D.6	Year of Construction	High	10 to 25 Years old	Mod.
D.6	Year of Construction	High	< 10 years old	Low
D.23	Superstructure Flexibility	Mod.	Steel Girder span length > 100 ft	High
D.23	Superstructure Flexibility	Mod.	PSC, Rolled, span length ≤ 100 ft	Low

Table C.21. Superstructure attributes and criteria damage mode of corrosion / section loss.

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR 7	Low
C.2	Current Element CS	High	CS 3 ≥ 5%	High
C.2	Current Element CS	High	CS 3 < 5%, CS 2 > 10% (DE 1000)	Mod.
C.2	Current Element CS	High	Other	Low
C.1 / C.2	Current CR / Current Element CS	Mod.	Deck CR 5, CS 3 ≥ 10% or 1120 (Eff) CS 2 > 10%	High
C.1 / C.2	Current CR / Current Element CS	Mod.	Deck CR 5	Mod.
C.1 / C.2	Current CR / Current Element CS	Mod.	Deck CR 6 or higher	Low
C.17	Coating Condition	High	Weathering Steel or Coated Steel: Beam End CS 3 DE 1000 or Steel Coating EL 515 CS 2 ≥ 25%, CS 3 ≥ 10%	High
C.17	Coating Condition	High	El. 515 10% ≤ CS 2 < 25%, 1% ≤ CS 3 < 10%	Mod.
C.17	Coating Condition	High	Coated steel: Metalized or Galvanized Steel, Lead-based, Good Paint El. 515 CS2 < 10%, CS 3 < 1%	Low
C.4	Joint Condition	High	Joint in CR 4 & 5 CS3 ≥5 %, CS 2 ≥ 20% or joint seal leakage DE 2310 CS 3 (any amount) or CS 2 ≥ 1%	High
C.4	Joint Condition	High	Joint in CR 6, 0 < CS3 < 5%, 5% < CS 2 < 20% DE 2310 0 < CS2 < 1%	Mod.
C.4	Joint Condition	High	Jointless / joint in CR ≥ 7, CS 2 ≤ 5%	Low
L.5	Rate of Deicing Chemical Application	High	North of I-80 and High ADT (> 10,000 vpd)	High
L.5	Rate of Deicing Chemical Application	High	Between I-70 and I-80 and High ADT (> 10,000 vpd)	Mod.
L.5	Rate of Deicing Chemical Application	High	South of I-70 or Low ADT (≤ 10,000 vpd)	Low
L.6	Subjected to Overspray		VC under 17 ft	High
L.6	Subjected to Overspray		VC 17 to 24 ft	Mod.
L.6	Subjected to Overspray		VC > 24 ft	Low
D.4 / C.7	Poor Deck Drainage / Effectiveness of Deck Drainage System		Deck pre-1980's construction, drainage onto superstructure or deck DE 1120 (efflorescence) CS 3	High
D.4 / C.7	Poor Deck Drainage / Effectiveness of Deck Drainage System		Post-1980's Deck in good condition typical drainage	Low

Table C.22. Fatigue cracking damage mode attributes and criteria (IL).

Code	Attribute	Rank	Criteria	Rating
C.2	Current Element CS	Mod.	CS 3 > 10% or Defect Element 1010 CS 2	High
C.2	Current Element CS	Mod.	CS 3 ≤ 10 %	Low
L.1	Average Daily Truck Traffic	Mod.	ADTT ≥ 5,000 tpd	High
L.1	Average Daily Truck Traffic	Mod.	500 tpd < ADTT < 5000 tpd	Mod.
L.1	Average Daily Truck Traffic	Mod.	ADTT ≤ 500 tpd	Low
L.4	Likelihood of Overload	Mod.	Permit routes / Structure is load posted	High
L.4	Likelihood of Overload	Mod.	Structure is not load posted	Low
D.17	Worst Fatigue Detail Category	High	Category D details or out-of-plane distortion details (1980 and before), coped beams	High
D.17	Worst Fatigue Detail Category	High	Category A, B, or C details	Low
D.6	Year of Construction	Mod.	Bridge designed before 1975 / unknown	High
D.6	Year of Construction	Mod.	Bridge designed between 1976 and 1984	Mod.
D.6	Year of Construction	Mod.	Bridge designed between 1985 and 1993	Minor
D.6	Year of Construction	Mod.	Bridge designed after 1994	Low

Table C.23. Impact damage attributes and criteria (IL).

Code	Attribute	Rank	Criteria	Rating
D.3	Minimum Vertical Clearance	Mod.	VC < 15 ft	High
D.3	Minimum Vertical Clearance	Mod.	15 ft to 17 ft	Mod.
D.3	Minimum Vertical Clearance	Mod.	> 17 ft	Low
D.25	Feature Under	High	Roadway, high ADT, ≥ 9,000 vpd	High
D.25	Feature Under	High	Roadway, moderate ADT, 2,000 vpd <ADT < 9,000 vpd	Mod.
D.25	Feature Under	High	Roadway with low ADT, ADT < 2,000 vpd	Low

Table C.24. Concrete substructure damage mode, attribute, and attribute's criteria (IL).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element CS	High	CS 3 ≥ 5% or CS 2 ≥ 20%	High
C.2	Current Element CS	High	1% ≤ CS 3 < 5% or 5% ≤ CS 2 < 20%	Mod.
C.2	Current Element CS	High	CS 3 < 1% or CS 2 < 5%	Low
C.4	Joint Condition	High	Joint in CR 4 & 5 CS 3 ≥ 5%, CS 2 ≥ 20% or joint seal leakage DE 2310 CS 3 (any amount) or CS 2 ≥ 1%	High
C.4	Joint Condition	High	Joint in CR 6, 0 < CS 3 < 5%, 5% < CS 2 < 20% DE 2310 0 < CS 2 < 1%	Mod.
C.4	Joint Condition	High	Jointless/joint in CR ≥ 7, CS 2 ≤ 5%	Low
L.5	Rate of De-icing Chemical Application	High	North of I-80 and High ADT, ADT > 10,000 vpd)	High
L.5	Rate of De-icing Chemical Application	High	Between I-70 and I-80 and High ADT, ADT > 10,000 vpd	Mod.
L.5	Rate of De-icing Chemical Application	High	South of I-70 or Low ADT (≤ 10,000 vpd)	Low
L.6	Subject to Overspray	High	Roadway, HC < 20 ft	High
L.6	Subject to Overspray	High	Waterway below or roadway, 20 ft ≤ HC < 30 ft	Mod.
L.6	Subject to Overspray	High	Feature under is not a waterway, HC ≥ 30 ft	Low
D.26	Corrosion Protection Level	High	CP 1	Very high
D.26	Corrosion Protection Level	High	CP 2	High
D.26	Corrosion Protection Level	High	CP 3	Mod.
D.26	Corrosion Protection Level	High	CP 4	Low

Table C.25. Risk model for substructure cracking due to rotation or settlement (IL).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element CS	High	CS 3 ≥ 10% DE 1130	High
C.2	Current Element CS	High	CS 3 1% ≤ CS 3 < 10% DE 1130	Mod.
C.2	Current Element CS	High	CS 3 < 1% DE 1130	Low
C.3	Evidence of Rotation or Settlement	High	DE 4000 - CS 3 ≥ 10%, or noted moderate to severe rotation or settlement	High
C.3	Evidence of Rotation or Settlement	High	DE 4000 - CS 3 < 10%, CS 2 or noted minor settlement	Mod.
C.3	Evidence of Rotation or Settlement	High	DE 4000 CS 1, no noted settlement	Low

Table C.26. Table showing attributes for vehicle impact for substructures (IL).

Code	Attribute	Rank	Criteria	Rating
-	Lateral Clearance	Mod.	Unprotected, ≤ 50 ft	High
-	Lateral Clearance	Mod.	Unprotected > 50 ft, ≤ 100 ft	Mod.
-	Lateral Clearance	Mod.	> 100 ft or protected	Low
D.25	Feature Under	High	Roadway, high ADT, ADT ≥ 9,000 vpd	High
D.25	Feature Under	High	Roadway, moderate ADT, 2,000 vpd ≤ ADT < 9,000 vpd	Mod.
D.25	Feature Under	High	Roadway with low ADT, ADT < 2,000 vpd)	Low

Table C.27. Table showing attributes for vessel impact for substructures (IL).

Code	Attribute	Rank	Criteria	Rating
D.25	Feature Under	Mod.	Navigable waterway (Mississippi, Illinois river, etc.)	High
D.25	Feature Under	Mod.	Other	Low
-	Substructure Navigation Protection	High	Pier or abutment protection requires evaluation. (Item 111, code 4, 5)	High
-	Substructure Navigation Protection	High	Pier or abutment protection in place but in deteriorated condition. (Item 111, code 3)	Mod.
-	Substructure Navigation Protection	High	Pier or abutment protection in place and functioning, or not required. (Item 111, code 1,2)	Low

C.5 Missouri Risk Models

C.5.1 Damage Modes

Table C.28. Listing of damage modes for Missouri steel bridges.

Component	Damage Mode
Deck	Delamination / Spalling
Steel Superstructure	Corrosion / Section Loss
Steel Superstructure	Fatigue
Steel Superstructure	Impact
PSC Superstructures	Spalling
Concrete Substructure	Delamination / Spalling
Steel Substructure	Corrosion Damage

C.5.2 Screening Criteria

Table C.29. Deck, superstructure & substructure screening attributes and criteria (MO).

Code	Attribute	Criteria
S.1	Current Element CR	CR ≤ 4
S.16	Current Element CS	CS 4
S.17	Construction Quality	Substandard construction quality
C.18	Condition of Fatigue Cracks	Presence of arrested / retrofitted fatigue cracking
C.18	Fabrication Defects	Welding Defects, reported in inspection report
C.18	Connection Damage	Defective connections reported in inspection report
-	Buckling	Local bridges constructed prior to 1950
S.13	E of E' Details	E or E' details
-	Camber / Sag	Camber / Sag issues reported from inspection.
-	Bearings damage and Girder movement	Tipping bearings reported in inspection report or closed joints indicating girder movement or Joint CR ≤ 3, CS 4.
C.28	Presence of Repair Areas	Previously impacted with reported heat-straightening.
-	Scaling	Severe-Loss of surface mortar and coarse aggregate particle > 1 in. deep, rebar exposed (CS 3 > 10%).

C.5.3 Risk Models

Table C.30. Deck damage mode, attribute, and attribute's criteria (MO).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
			CR 6	Mod.
			CR ≥ 7	Low
C.2	Current Element CS	High	CS 3 ≥ 10%	High
			1% < CS 3 < 10%, CS 2 > 20%	Mod.
			CS 3 ≤ 1%, CS 2 ≤ 20%	Low
C.13	Efflorescence / Staining	High	> 10% of deck water saturated (CR 5) or efflorescence with rust staining	High
			1% - 10% of deck water saturated or efflorescence without rust staining	Mod.
			Deck not saturated, < 1% efflorescence	Low
C.27	Rate of Deterioration	Mod.	CR 6 < 22 years after construction	High
			CR 7 < 9 yrs 9 years after construction	Mod.
			All others	Low
L.1	ADT / ADTT	High	ADT ≥ 7000 vpd, ADTT ≥ 500 tpd	High
			500 vpd < ADT < 7000 vpd, 50 tpd < ADTT < 500 tpd	Mod.
			ADT ≤ 500 vpd, ADTT ≤ 50 tpd	Low
L.5	Rate of De-icing Chemical Application	High	I-70 and north of I-70, or urban area	High
			NHS bridges south of I-70	Mod.
			South of I-70, non-urban, non-NHS	Low
D.4 / C.7	Poor Deck Drainage and Ponding / Effectiveness of Deck Drainage System	High	Poor deck drainage, ponding on deck	High
			Slope / grade < 1%	Mod.
			Other	Low
D.26	Corrosion Protection Level	High	CP 1	Very High
			CP 2	High
			CP 3	Mod.
			CP 4	Low
D.23	Superstructure Flexibility	Mod.	Highly flexible superstructure	High
			Common flexibility characteristics	Low
D.8	Concrete Mix Design	High	Under-performing mix design	High
			The concrete used is not considered to be high performance.	Mod.
			The concrete used satisfies high performance conditions.	Low

Table C.31. Superstructure damage mode of corrosion / section loss (MO).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CCR	High	CR 5	High
C.1	Current CCR	High	CR 6	Mod.
C.1	Current CCR	High	CR ≥ 7	Low
C.2	Element CS	High	CS 3 ≥ 10%	High
C.2	Element CS	High	1% < CS 3 < 10%, CS 2 > 20%	Mod.
C.2	Element CS	High	CS 3 ≤ 1%	Low
C.17	Coating Condition	High	CR ≤ 4, EL 515 CS 2 ≥ 25%, CS 3 ≥ 10%, CS 4 ≥ 1% weathering steel w/o patina	High
C.17	Coating Condition	High	CR 5-6, 10% ≤ CS 2 < 25%, 1% ≤ CS 3 < 10%, CS 4 < 1% or weathering steel with patina	Mod.
C.17	Coating Condition	High	CR ≥7	Low
C.4	Joint Condition	High	Leaking or CR ≤ 4, CS 3 ≥ 25%, CS 4 > = 5%	High
C.4	Joint Condition	High	Not leaking or CR 5-6, 5% < CS 3 < 25%, CS 4 < 5%	Mod.
C.4	Joint Condition	High	Jointless or Joint in CR 7-9, CS 3 ≤ 5%	Low
L.1	ADT / ADTT	High	≥ 7,000 ADT, ≥ 500 Trucks	High
L.1	ADT / ADTT	High	500 < ADT < 7,000, 50 < Trucks < 500	Mod.
L.1	ADT / ADTT	High	≤ 500 ADT, ≤ 50 Trucks	Low
L.5	Rate of De-icing Chemical Application	Mod.	I-70 and north of I-70, or urban area	High
L.5	Rate of De-icing Chemical Application	Mod.	NHS bridges south of I-70	Mod.
L.5	Rate of De-icing Chemical Application	Mod.	South of I-70, non-urban, non-NHS	Low
L.6	Subjected to Overspray	High	Over traffic, VC < 20 ft, Over lake-continuous wet environment, VC < 10 ft	High
L.6	Subjected to Overspray	High	Stream, VC < 6 ft from water	Mod.
L.6	Subjected to Overspray	High	Other	Low
C.7	Poor Deck Drainage and Ponding / Quality of Deck Drainage System	Mod.	Short or no down spout on deck drains, open grating, timber decks	High
C.7	Poor Deck Drainage and Ponding / Quality of Deck Drainage System	Mod.	Slab drain, curb outlet with downspout	Mod.
C.7	Poor Deck Drainage and Ponding / Quality of Deck Drainage System	Mod.	Typical drainage	Low
D.6	Year of Construction	Mod.	Before 1985	High
D.6	Year of Construction	Mod.	1985 or later	Low

Table C.32. Cracking damage mode attributes and criteria (MO).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element CS	Mod.	Significant amount of corrosion present CS 3 > 5%	High
C.2	Current Element CS	Mod.	Mod. amount of corrosion present, CS 3 ≤ 5%	Mod.
C.2	Current Element CS	Mod.	Minor, localized corrosion, no CS 3	Low
L.1	ADT / ADTT	High	ADT ≥ 7,000 vpd, ADTT ≥ 500 tpd	High
L.1	ADT / ADTT	High	500 vpd < ADT < 7,000 vpd, 50 tpd < ADTT < 500 tpd	Mod.
L.1	ADT / ADTT	High	ADT ≤ 500 vpd, ADTT ≤ 50 tpd	Low
L.4	Likelihood of Overload	Mod.	High Likelihood of overload	High
L.4	Likelihood of Overload	Mod.	Moderate likelihood of overload	Mod.
L.4	Likelihood of Overload	Mod.	Low likelihood of overload	Low
D.17	Worst Fatigue Detail Category	High	Cross Frames / Web Distance Out-of-Plane / Web gap pre-1985	High
D.17	Worst Fatigue Detail Category	High	Category of Details categories A-D with High ADTT, ADTT ≥ 500 tpd	Mod.
D.17	Worst Fatigue Detail Category	High	Category of Details (A-D) and/or Low ADTT, ADTT < 500 tpd	Low
D.2	Load Posting / Likelihood of Overload	Mod.	H 10, H 15, H 20 design loading, one lane pre-1965	High
D.2	Load Posting / Likelihood of Overload	Mod.	Non-interstate bridges HS 20 inventory rating < 36 tons	High
D.2	Load Posting / Likelihood of Overload	Mod.	Other	Low
D.6	Year of Construction	Mod.	Bridge designed before 1975 / unknown	High
D.6	Year of Construction	Mod.	Bridge designed between 1976 and 1984	Mod.
D.6	Year of Construction	Mod.	Bridge designed between 1985 and 1993	Minor
D.6	Year of Construction	Mod.	Bridge designed after 1994	Low

Table C.33. Impact damage attributes and criteria (MO).

Code	Attribute	Rank	Criteria	Rating
D.3	Minimum Vertical Clearance	High	≤ 15 ft	High
D.3	Minimum Vertical Clearance	High	Other	Low
D.25	Feature Under	High	Roadway, high ADT (ADT ≥ 5,000 vpd, ≥ 500 tpd)	High
D.25	Feature Under	High	Roadway, moderate ADT, 500 vpd < ADT < 5,000 vpd, 50 tpd < ADTT < 500 tpd	Mod.
D.25	Feature Under	High	Waterway or Roadway, low ADT, ADT ≤ 500 vpd, ADTT ≤ 50 tpd)	Low

Table C.34. Attributes for PSC bridges (MO).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
			CR 6	Mod.
			CR ≥ 7	Low
C.2	Element Condition State	High	≥ 10% element in CS 3	High
			1% < CS 3 < 10%, CS 2 > 20%	Mod.
			CS 3 ≤ 1%	Low
C.4	Joint Type / Joint Condition	Mod.	Leaking or CR ≤ 4, CS 3 ≥ 25%	High
			Not leaking or CR 5-6, 5% < CS3 < 25%	Mod.
			Jointless or Joint in CR 7-9, CS 3 ≤ 5%	Low
C.13	Efflorescence / Staining	High	➢ 10% of deck water saturated (CR 5) or efflorescence with rust staining	High
			1% - 10% of deck water saturated or efflorescence without rust staining	Mod.
			Deck not saturated, < 1% efflorescence	Low
L.1B	ADTT	High	ADT ≥ 7,000 vpd, ADTT ≥ 500 tpd	High
			500 vpd < ADT < 7,000 vpd, 50 tpd < ADTT < 500 tpd	Mod.
			ADT ≤ 500 vpd, ADTT ≤ 50 tpd	Low
L.5	Rate of Deicing Chemical Application	Mod.	I-70 and north of I-70, or urban area	High
			NHS bridges south of I-70	Mod.
			South of I-70, non-urban, non-NHS	Low
C.7	Quality of Deck Drainage System	Mod.	Short or no down spout on deck drains, open grating, timber decks	High
			Slab drain, Curb outlet with downspout	Mod.
			Typical drainage	Low
L.6	Subjected to Overspray	High	Over Traffic, < 20 ft vertical clearance, Over lake-continuous wet environment (< 10 ft nominal)	High
			Stream, < 6 ft VC from water	Mod.
			Other	Low

Table C.35. Concrete substructure damage mode, attribute, and attribute's criteria (MO).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element Condition State (Delam., Spalling, Scaling, or Wide Crack-Element CS)	High	CS 3 ≥ 10% or CS 2 ≥ 20% by sounding Scaling: Loss of surface mortar between 1/2" & 1" deep, exposed coarse aggregate	High
C.2	Current Element Condition State (Delam., Spalling, Scaling, or Wide Crack-Element CS)	High	10% ≤ CS 2 < 20%, 1% < CS 3 < 10% or exposed rebar. Scaling: Loss of surface mortar between 1/4" & 1/2" deep, mortar loss between coarse aggregate	Mod.
C.2	Current Element Condition State (Delam., Spalling, Scaling, or Wide Crack-Element CS)	High	< 10% CS 2, CS 3 ≤ 1% Scaling: Light-Loss of surface mortar up to 1/4" deep with surface exposure of coarse aggregates	Low
C.13	Efflorescence / Staining	High	Moderate to severe efflorescence with rust staining or severe efflorescence without rust staining	High
C.13	Efflorescence / Staining	High	Moderate efflorescence without rust staining	Mod.
C.13	Efflorescence / Staining	High	Little or no efflorescence reported	Low
C.4	Joint Condition	High	Leaking or CR ≤ 4, CS 3 ≥ 25%	High
C.4	Joint Condition	High	Not leaking or CR 5-6, 5% < CS 3 < 25%	Mod.
C.4	Joint Condition	High	Jointless or Joint in CR 7-9, CS 3 ≤ 5%	Low
L.5	Rate of Deicing Chemical Application	High	I-70 and north of I-70, or urban area	High
L.5	Rate of Deicing Chemical Application	High	NHS bridges south of I-70	Mod.
L.5	Rate of Deicing Chemical Application	High	South of I-70, non-urban, non-NHS	Low
D.25	Feature Under	Mod.	Feature under is a waterway	High
D.25	Feature Under	Mod.	Feature under is not a waterway	Low
D.26	Corrosion Protection Level	High	CP 1	Very high
D.26	Corrosion Protection Level	High	CP 2	High
D.26	Corrosion Protection Level	High	CP 3	Mod.
D.26	Corrosion Protection Level	High	CP 4	Low

Table C.36. Risk model for steel substructures (MO).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element CS	High	CS 3 ≥ 10%, or lamellar corrosion reported	High
C.2	Current Element CS	High	CS 3 1% to < 10%, CS 2 ≥ 25%	Mod.
C.2	Current Element CS	High	CS 2 < 25%, no CS 3	Low
C.17	Coating Condition	High	CR ≤ 4	High
C.17	Coating Condition	High	CR 5-6, weathering steel w/o patina	Mod.
C.17	Coating Condition	High	CR 7, 8, 9 or weathering steel with patina, galvanized	Low
C.28	Presence of Repair Area	High	Significant amount of repair	High
C.28	Presence of Repair Area	High	Moderate amount of repair	Mod.
C.28	Presence of Repair Area	High	Minor amount of repair or no repair	Low
C.4	Joint Condition	High	Leaking or CR ≤ 4, CS 3 ≥ 25%	High
C.4	Joint Condition	High	Not leaking or CR 5-6, 5% < CS 3 < 25%	Mod.
C.4	Joint Condition	High	Jointless or Joint in CR 7-9, CS 3 ≤ 5%	Low
L.5	Rate of De-icing Chemical Application	High	I-70 and north of I-70, or urban area	High
L.5	Rate of De-icing Chemical Application	High	NHS bridges south of I-70	Mod.
L.5	Rate of De-icing Chemical Application	High	South of I-70, non-urban, non-NHS	Low
D.25	Feature Under	Mod.	Feature under is a waterway	High
D.25	Feature Under	Mod.	Feature under is not a waterway	Low

C.6 Washington Risk Models

C.6.1 Damage Modes

Table C.37. Listing of damage modes for Washington PSC Bridges.

Component	Damage Mode
Deck	Delamination / Spalling
Superstructure	Delamination / Spalling / Cracking
Superstructure	Impact Damage
Substructure	Delamination / Spalling and Cracking Due to Corrosion

C.6.2 Screening Criteria

Table C.38. Deck, superstructure & substructure screening attributes and criteria (WA).

Code	Attribute	Criteria
S.1	Current CR	CR ≤ 4
S.16	Current Element CS	Element in CS 4
D.6	Year of Construction	Deck constructed in 1965 or earlier
S.17	Construction Quality	Localized defects or flaws/ Poor construction practice
S.18	Exposed Strand due to Impact	Exposed strand DE 1100 CS 2, 3 from vehicle impact DE 7000 (Impact Damage) or reported mid-span exposed strand
S.10	Design Features	Bridge has timber piles
S.16	Current Element CS	Bearings in CS 3, 4 & CR ≤ 4

C.6.3 Risk Models

Table C.39. Deck damage mode, attribute, and attribute's criteria (WA).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	Mod.	CR 5	High
C.1	Current CR	Mod.	CR 6	Mod.
C.1	Current CR	Mod.	CR ≥ 7	Low
C.2	Current Element CS	High	CS 3 ≥ 5% or CS 2 ≥ 20% Abrasion/ Wear DE 1190 CS 3 ≥ 10%	High
C.2	Current Element CS	High	1% ≤ CS3 < 5% DE 1080-1130 or 5% ≤ CS 2 < 20%, 5% ≤ CS 3 < 10% DE 1190	Mod.
C.2	Current Element CS	High	CS 3 < 1% or CS 2 < 5%	Low
L.1	Average Daily Truck Traffic	Mod.	ADTT ≥ 1,000 tpd	High
L.1	Average Daily Truck Traffic	Mod.	ADTT < 1,000 tpd	Low
L.5	Rate of De-icing Chemical Application	High	Eastern Urban / Interstate routes Passes – three major routes, two US routes plus one interstate route	High
L.5	Rate of De-icing Chemical Application	High	Other routes	Low
L.3	Exposure Environment	Mod.	Severe/Marine	High
L.3	Exposure Environment	Mod.	Moderate / industrial or West of Cascade	Mod.
L.3	Exposure Environment	Mod.	Benign or East of Cascade	Low
L.4	Likelihood of Overload	Low	High likelihood of overload	High
L.4	Likelihood of Overload	Low	Moderate likelihood of overload	Mod.
L.4	Likelihood of Overload	Low	Low likelihood of overload	Low
D.26	Corrosion Protection Level*	Low	CP 1	Very High
D.26	Corrosion Protection Level*	Low	CP 2	High
D.26	Corrosion Protection Level*	Low	CP 3	Mod.
D.26	Corrosion Protection Level*	Low	CP 4	Low

Table C.40. PSC superstructure damage mode of delamination / spalling (WA).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element CS	Mod.	CS 3 ≥ 1% or CS 2 ≥ 20%	High
C.2	Current Element CS	Mod.	CS 3 < 1% or 5% ≤ CS 2 < 20%	Mod.
C.2	Current Element CS	Mod.	CS 3, CS 2 < 5%	Low
C.9	General Cracking	Mod.	Widespread or severe cracking (DE 1110, CS 3 (any), or CS 2 > 20%)	High
C.9	General Cracking	Mod.	Moderate cracking present (DE 1110, 0 < CS2 ≤ 20%)	Mod.
C.9	General Cracking	Mod.	Minor or no cracking present (DE 1110, CS 1)	Low
C.4	Joint Type / Joint Condition	Low	Joint in CR 4 & 5, Failed, or Leaking or Joint CS 3 ≥ 5%, CS 2 ≥ 20%	High
C.4	Joint Type / Joint Condition	Low	Joint in CR 6, or Joint 0 < CS 3 < 5%, 5% < CS 2 < 20%	Mod.
C.4	Joint Type / Joint Condition	Low	Jointless or Joint in CR ≥ 7 or Joint In-place with joint CS 2 ≤ 5%, no CS 3	Low
C.22	Presence of Debris	Mod.	Debris is or is likely to be present NBI Item 71 CR ≤ 4 (overtopping), (SNBI B.AP.02 ≥ 5), or reported build-up of debris	High
C.22	Presence of Debris	Mod.	Debris not likely to be present, NBI Item 71 > 4	Low
L.1B	ADTT	High	ADTT ≥ 1,000 tpd	High
L.1B	ADTT	High	ADTT < 1,000 tpd	Low
L.5	Rate of De-icing Application	Mod.	Eastern urban / Interstate routes - Passes – three major routes, two US routes and one Interstate route	High
L.5	Rate of De-icing Application	Mod.	Other routes	Low
L.3	Exposure Environment	Mod.	Severe / Marine	High
L.3	Exposure Environment	Mod.	Moderate / Industrial or West of Cascade	Mod.
L.3	Exposure Environment	Mod.	Benign or East of Cascade	Low
D.11	Minimum Concrete Cover	High	Cover ≤ 1.5 in., unknown	High
D.11	Minimum Concrete Cover	High	1.5 inches < Cover < 2.5 in.	Mod.
D.11	Minimum Concrete Cover	High	Cover > 2.5 in.	Low

Table C.41. Washington PSC impact damage attributes and criteria.

Code	Attribute	Rank	Criteria	Rating
D.3	Minimum Vertical Clearance	Mod.	14 ft ≤ VC < 15 ft	High
D.3	Minimum Vertical Clearance	Mod.	15 ft ≤ VC ≤ 17 ft	Mod.
D.3	Minimum Vertical Clearance	Mod.	VC > 17 ft	Low
D.25	Feature Under	High	High ADT / ADTT, ADT ≥ 5,000 vpd, ADTT ≥ 500 tpd	High
D.25	Feature Under	High	Moderate ADT, (500 vpd < ADT < 5,000 vpd, 50 tpd < ADTT < 500 tpd)	Mod.
D.25	Feature Under	High	Low ADT / ADTT, ADT ≤ 500 vpd, ADTT ≤ 50 tpd	Low

Table C.42. Concrete substructure damage mode, attribute, and attribute's criteria (WA).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
			CR 6	Mod.
			CR ≥ 7	Low
C.2	Current Element CS	High	CS 3 ≥ 5% or CS 2 ≥ 30%	High
			1% ≤ CS 3 < 5% or 5% ≤ CS 2 < 30%	Mod.
			CS 3 < 1% or CS 2 < 5%	Low
C.4	Joint Condition	High	Joint in CR 4 & 5, Failed, or Leaking Or Joint CS 3 ≥ 5%, CS 2 ≥ 20%	High
			Joint in CR 6, or Joint 0 < CS 3 < 5%, 5% < CS 2 < 20%	Mod.
			Jointless or Joint in CR ≥ 7 or Joint In-place with joint CS 2 ≤ 5%, no CS 3	Low
L.5	Rate of De-icing Chemical Application	Mod.	Eastern urban / interstate routes - Passes – 3 majors, 2 US routes / Interstate Routes)	High
			Other routes	Low
L.3	Exposure Environment	Mod.	Severe / Marine	High
			Moderate / Industrial or West of Cascade	Mod.
			Benign or East of Cascade	Low
L.6	Subjected to Overspray	Low	Eastern urban / interstate routes - Passes – 3 majors, 2 US routes / Interstate Routes) Feature under: Roadway, horizontal clearance ≤ 15 ft	High
			Benign -Other routes, Feature under is not a roadway or horizontal clearance > 15 ft	Low
D.4 / C.7	Poor Deck Drainage / Effectiveness of Deck Drainage System	Mod.	Deck drains directly onto superstructure or substructure components, or ponding on deck results from poor drainage	High
			Drainage issues resulting in drainage onto superstructure or substructure components, or moderate ponding on deck; effects may be localized	Mod.
			Adequate quality	Low

C.7 Wisconsin Risk Models

C.7.1 Damage Modes

Table C.43. Listing of damage modes for Wisconsin steel bridges

Component	Damage Mode
Deck	Delamination / Spalling
Superstructure	Corrosion / Section Loss
Superstructure	Fatigue
Superstructure	Impact
Substructure	Delamination / Spalling

C.7.2 Screening Criteria

Table C.44. Deck, superstructure & substructure screening attributes and criteria (WI).

Code	Attribute	Criteria
S.1	Current Condition Rating	CR ≤ 4
S.16	Current Element Condition State	CS 4
S.16	Current Element Condition State	Bearing in CS 3, 4 & CR ≤ 4
S.10	Design Features - Suspended Spans	Pin and Hanger connection
S.10	Design Features	Jointless Steel Bridge with Embedded Girders, Significant CS 3, CS 4 Defect element 1000 Located at embedment
S.3	Susceptible to Collision	Bridge has been previously impacted causing moderate damage
S.16	Current Element Condition State	CS 3 or CS 4 in primary member's connection
S.8	Details Susceptible to CIF	Structure contains details susceptible to CIF, and / or cover plates with transverse welds in tension zones
S.17	Construction Quality	Localized defects or flaws / Poor construction practice
S.10	Design Feature	Evidence of poor geometry, high skew angle

C.7.3 Risk Models

Table C.45. Deck damage mode, attribute, and attribute's criteria (WI).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
			CR 6	Mod.
			CR ≥ 7	Low
C.2	Current Element CS (or plow damage)	High	Deck surface (El. 510) CS 3 > 10%, or Element 12 > 5%	High
			Deck surface (EL. 510) CS 3 1-10%, CS 2 ≥ 15%, or 1% ≤ Element 12 ≤ 5%	Mod.
			Deck surface (510) CS 1 or CS 2 < 15%, CS 3 < 1%, Element 12 CS 3 < 1%	Low
C.13	Efflorescence / Staining (Deck Soffit)	High	Deck element soffit >5%	High
			Deck element soffit 1% ≤ CS 3 ≤ 5%	Mod.
			Deck element soffit < 1%	Low
L.1	ADT / ADTT	High	ADT ≥ 20,000 vpd	High
			10,000 vpd ≤ ADT < 20,000 vpd	Mod.
			ADT < 10,000 vpd	Low
L.5	Rate of De-icing Chemical Application	High	Interstate / Urban or ADT ≥ 10,000 vpd	High
			Rural, non-interstate, 2,000 vpd < ADT < 10,000 vpd	Mod.
			Rural, Non- Interstate, ADT ≤ 2,000 vpd	Low
L.2	Dynamic Loading from Riding Surface	Mod.	Dynamic forces leading to increase rate of deterioration a significant consideration (ADE9324 CS4)	High
			Dynamic forces not a significant consideration	Low
C.7	Poor Deck Drainage and Ponding / Quality of Deck Drainage	High	Element 9004 Deck drainage: CS 3 or open rails w/ no down spout	High
			Element 9004 Deck drainage: CS 2	Mod.
			Element 9004 Deck drainage: CS 1	Low
D.26	Corrosion Protection Level	High	CP 1	Very High
			CP 2	High
			CP 3	Mod.
			CP 4	Low
C.29	Testing Result	High	No NDT on deck	High
			The bridge is subject to NDT	Low

Table C.46. Superstructure attributes and criteria for the damage mode of corrosion / section loss (WI).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
			CR 6	Mod.
			CR ≥ 7	Low
C.2	Current Element CS	High	CS 3 ≥ 10% Section Loss (DE 1000)	High
			CS 2 ≥ 20%, 1% < CS 3 < 10%	Mod.
			CS 1, CS 2 < 20%, CS 3 < 1%	Low
D.15 / C.17	Constructed of Weathering Steel / Coating Condition	Mod.	Protective Coating or Weathering Steel Corrosion in CS 3 > 10% and / or CS 4 > 1% (BME 515)	High
			Protective Coating or Weathering Steel Corrosion in CS 2 > 20%	Mod.
			Protective Coating or Weathering Steel Corrosion in CS 1	Low
C.4	Joints Condition	High	CS 3 ≥ 10%, CR 4 > 1 % , CR 4 – Leaking joint	High
			CS 2 > 20% or 1% ≤ CS 3 ≤ 10%, CR 5, 6 – min. leakage	Mod.
			CS 1, CS 2 < 20%, CS 3 < 1%, CR = ≥ 7	Low
C.7	Effectiveness of Deck Drainage System	High	Element 9004 Deck drainage: CS 3 or open rails w/ no down spout	High
			Element 9004 Deck drainage: CS 2	Mod.
			Element 9004 Deck drainage: CS 1	Low
L.5	Rate of De-icing Chemical Application	High	Interstate / Urban or ADT > 10,000 vpd	High
			Rural, non-interstate, 2,000 vpd < ADT < 10,000 vpd	Mod.
			Rural, Non- Interstate, ADT < 2000 vpd	Low
L.6	Subjected to Overspray	Mod.	VC < 16 ft, Bridge over highway (Interstate) Bridge over non-Interstate, ADTT > 200 tpd	High
			16 ≤ VC ≤ 20 ft, bridge over highway (Interstate) Bridge over non-Interstate, ADTT > 200 tpd	Mod.
			Clearance > 20 ft	Low
D.13	Built-up Member	Low	Stiffeners welded / bolted to bottom flange or built-up members	High
			Stiffeners not welded / bolted to bottom flange, wide flange section or plate girder	Low

Table C.47. Cracking damage mode attributes and criteria (WI).

Code	Attribute	Rank	Criteria	Rating
C.2	Current Element CS	High	DE 1010 CS 3 un-arrested crack < 3'' length DE 1010	High
C.2	Current Element CS	High	CS 2 – Arrested Crack DE 1010	Mod.
C.2	Current Element CS	High	CS 1 DE 1010	Low
L.1	ADT / ADTT	High	ADT ≥ 20,000 vpd – 15% Trucks	High
L.1	ADT / ADTT	High	ADT 10,000 vpd – 20,000 vpd	Mod.
L.1	ADT / ADTT	High	ADT < 10,000 vpd	Low
D.17	Worst Fatigue Detail Category	High	E, E'	High/Screen
D.17	Worst Fatigue Detail Category	High	C, D	Mod.
D.17	Worst Fatigue Detail Category	High	A, B	Low
D.6	Year of Construction	Mod.	Bridge designed before 1975 / unknown	High
D.6	Year of Construction	Mod.	Bridge designed between 1975 and 1984	Mod.
D.6	Year of Construction	Mod.	Bridge designed between 1985 and 2008	Mod-Low
D.6	Year of Construction	Mod.	Higher toughness materials / Bridge designed after 2009	Low

Table C.48. Impact damage attributes and criteria (WI).

Code	Attribute	Rank	Criteria	Rating
D.3	Minimum Vertical Clearance	High	VC < 15 ft	High
D.3	Minimum Vertical Clearance	High	15≤ VC ≤ 17 ft	Mod.
D.3	Minimum Vertical Clearance	High	VC > 17 ft	Low
D.25	Feature Under	Mod.	Roadway, high ADT, ADT > 10,000 vpd	High
D.25	Feature Under	Mod.	Roadway, moderate ADT, 1000 ≤ ADT < 10,000 vpd	Mod.
D.25	Feature Under	Mod.	Roadway, low ADT, ADT < 1000 vpd	Low

Table C.49. Concrete substructure damage mode, attribute, and attribute's criteria (WI).

Code	Attribute	Rank	Criteria	Rating
C.1	Current CR	High	CR 5	High
C.1	Current CR	High	CR 6	Mod.
C.1	Current CR	High	CR ≥ 7	Low
C.2	Current Element CS	High	CS 2 ≥ 20% or CS 3 ≥ 10%	High
C.2	Current Element CS	High	1% ≤ CS 2 < 20%, 1% ≤ CS 3 < 10%	Mod.
C.2	Current Element CS	High	CS 2 < 1%, CS 3 < 1%	Low
C.4	Joint Condition	High	CS 3 >= 10%, CR 4 > 1 % – Leaking joint	High
C.4	Joint Condition	High	CS 2 > 20% or 1% ≤ CS 3 ≤ 10%, CR 5, 6 – min. leakage	Mod.
C.4	Joint Condition	High	CS 1, CS 2 < 20%, CS 3 < 1%, CR = ≥ 7	Low
C.7	Quality of Deck Drainage System	High	Element 9004 Deck drainage: CS 3 or open rails w/ no down spout	High
C.7	Quality of Deck Drainage System	High	Element 9004 Deck drainage: CS 2	Mod.
C.7	Quality of Deck Drainage System	High	Element 9004 Deck drainage: CS 1	Low
C.24	Bearing Condition Rating	High	CR 5, DE 2240 CS 3 ≥ 10%, CS 4 > 1%	High
C.24	Bearing Condition Rating	High	CR 6, DE 2240 1% ≤ CS 3 < 10%, CS 2 > 20%	Mod.
C.24	Bearing Condition Rating	High	CR ≥ 7	Low
L.6	Subjected to Overspray / Minimum Lateral Clearance	High	HC ≤ 10 ft	High
L.6	Subjected to Overspray / Minimum Lateral Clearance	High	10 ≤ HC ≤ 20 ft	Mod.
L.6	Subjected to Overspray / Minimum Lateral Clearance	High	HC > 20 ft	Low
D.11	Minimum Concrete Cover	Mod.	Cover < 1.5 in.	High
D.11	Minimum Concrete Cover	Mod.	1.5 ≤ Cover < 2.5 in.	Mod.
D.11	Minimum Concrete Cover	Mod.	Cover ≥ 2.5 in.	Low